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Introduction

The majority of therapeutic interventions in children require an accurate measurement of body weight. Therapeutic errors are more likely to occur if the patient's weight is unavailable or incorrectly estimated. For children undergoing elective operations it is possible to directly weigh them. In acute medical or surgical cases this is often not possible, so an estimation of the child's weight is necessary.

In 2011, the Advanced Pediatric Life Support (APLS) program recommended three age-based pediatric weight estimation formulae from age 1mth to 12yr. The APLS formula ($2 \times \text{age in yr.} + 8$) is recommended for children under 5yr while the Luscombe formula ($3 \times \text{age in yr.} + 7$) is suggested for children aged 6-12yr. Unfortunately, neither of these formulae has been rigorously assessed in overweight children. Given the rising prevalence of overweight and obese children, it is imperative to determine the accuracy of these commonly used age-based weight estimation formulae in children undergoing anesthesia. We hypothesized that these formulae will significantly underestimate the weight of contemporary US children, especially those in the overweight group.

Methods

Prospectively recorded anthropometric data and published body mass index (BMI) norms were used to classify children age 2-12yr who underwent elective non-cardiac operations into normal weight and overweight groups. Patients were further classified into under 5yr and age 6-12yr. The present investigation excludes obese children because they may be easier to identify by visual inspection and their true weights are inherently harder to estimate. Accuracy and precision of each weight estimation method were computed using the Bland-Altman method.

Results

There were 9865 children of whom 5665 (57.4%) were boys. Mean (SD) weight was 23.7(10.3) kg, mean (SD) height was 117 (20.0) cm, and mean (SD) BMI was 16.3 (2.1) kg/m². Measured and formula-derived weights were highly correlated ($r = 0.88$). There were 4403 (44.6%) under-five and 1828 (18.5%) overweight children in the study population.

The APLS formula underestimated the weights of normal BMI children (MPE = - 3.6; 95%CI = -4.05 to -3.14), although it was more accurate than the Luscombe formula in this group of patients. However among overweight children, the APLS formula was highly inaccurate demonstrating a MPE of -12.2 in under-five children and -25.0 in older children, indicating considerable underestimation of weight in these categories. Conversely, the Luscombe formula was more accurate in overweight children: MPE = 1.7 in under-five and -2.06 among older children, indicating a slight tendency to underestimate the weight of older, overweight children.

Conclusion

Although the APLS formula remains accurate and precise for weight estimation in under-five children, it tended to grossly underestimate the weight of overweight preschool and older children. The Luscombe formula appears to be a better weight estimation method in overweight pre-school children as well as in older children. The limitations of common weight estimation equations in the prevailing epidemic of childhood overweight/obesity should be noted. There is a need to develop a formula that is accurate and precise in overweight children.
